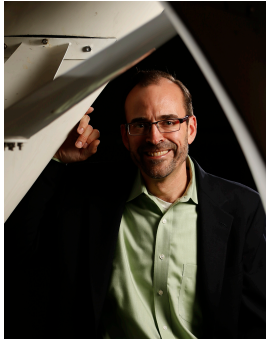


## Science of Signatures Advanced Studies Scholars Program 2014



**Speaker:** Douglas Adams, Distinguished Professor and Chair  
Civil and Environmental Engineering  
Professor of Mechanical Engineering  
Vanderbilt University

**Title:** If we can estimate it, we can control it.

**Abstract:** This talk discusses the critical importance of state awareness in controlling engineered systems. The word "awareness" implies knowledge of a system state that is gleaned using measured data in concert with a model of some kind. Load management in wind farms is first discussed to convey how some states like power output, although intuitively satisfying, sometimes fail to capture the quantities we wish to control. A smart blade technology with integrated inertial sensors is used to control the yaw set point, which reduces fatigue loads by up to 50%. The challenges in control for nonlinear dynamic systems are then discussed including state estimation. Derivative Free Filters are used to demonstrate prognosis-based control of an actuator in a fully nonlinear six degree-of-freedom flight mechanics model of a high performance aircraft. The rate of degradation in the actuator piston ring is substantially reduced through control reconfiguration. Finally, the importance of developing new ways to sense physical behavior is highlighted by listening to lithium ion batteries. The ion saturation of anodes is sensed to enable the battery management system to intelligently control charge and discharge in hybrid vehicle power cells to avoid capacity fade and extend the life of batteries.

The speaker also emphasizes the critical role that relationship building has played in sponsored research throughout the talk.

**Bio:** Dr. Adams is Distinguished Professor and Chair of Civil and Environmental Engineering at Vanderbilt University and Professor of Mechanical Engineering. His research in structural health monitoring identifies unique signatures that illuminate how

materials and machines degrade in order to prevent failure in energy, security, transportation, and manufacturing related applications. He has written 240 technical papers, and authored a textbook on structural health monitoring as well as several book chapters, including recent chapters on damage prognosis of aerospace structures, structural health monitoring of wind turbines, and monitoring of civil infrastructure. Research awards he has received include the Presidential Early Career Award for Scientists and Engineers and Society of Experimental Mechanics DeMichele Award, and he was elected a Fellow of ASME in 2011. He has supervised 54 M.S. and Ph.D. students and 30 undergraduate research assistants, and now advises 6 graduate students. He has been interacting with researchers at Los Alamos National Laboratory since his first visit to the lab in 1999.